CHARACTERISTICS OF SCREW PUMPS

By R. K. ANNIS, B.M.E., '21

The screw pump has a number of very important advantages compared with centrifugal pumps. In order, however, to appreciate fully what the screw pump will do as compared with the centrifugal pump, particularly for low head operation, it is necessary to have a thorough knowledge of the characteristic curves of both types of pumps.

The three curves which are reproduced here show an actual comparison between a screw pump and a 36-in. centrifugal pump. A great deal of care has been taken to make this comparison as fair as possible; but owing to the dissimilarity of the characteristics of the two pumps, a perfect comparison is practically impossible. For this reason, wherever it is impossible to make the conditions coincide exactly for the two different pumps, the centrifugal pump has been given every advantage, yet even under rather severe handicaps, the screw still maintains its supremacy under low head conditions.

The combined curve shown in Fig. 3 illustrates that at all heads lower than 12.6 ft. the screw pump is the more efficient of the two pumps. It will be noticed that the 42-in. centrifugal has not been compared with the 42-in. screw pump because the screw pumps are designed for such very low heads that the suction and discharge sizes are made larger than the connections for centrifugal pumps which handle the same capacity. In other words, the 42-in. centrifugal pump would have a capacity so much greater than that of the 42-in. screw that comparison would be impossible. All of the total heads which are shown in the three curves are total dynamic heads, and this includes the velocity head. Therefore, the water delivered from the screw pump is moving at a lower velocity because of the size of pipe, and hence it is in a more usable form. The entrance losses of the suction pipe and the losses due to recovery of velocity head at the discharge pipe are not as great.

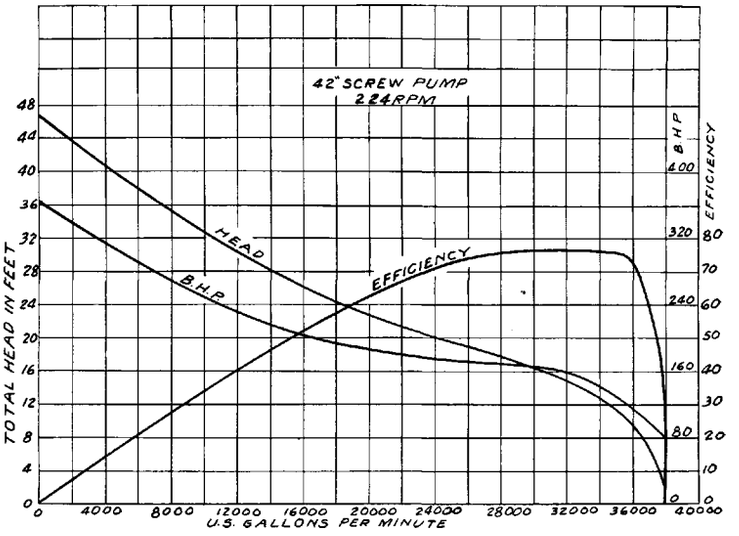


Fig. 1. Complete performance curve showing 42-in. screw pump at 360 r.p.m.

It has often been stated that the speed of a screw pump can be much higher than that of a centrifugal operating under the same conditions. These curves demonstrate this beyond a doubt. It will be noted that the centrifugal pump operates at 224 r.p.m., while the screw pump operates at a speed more than 50 per cent in excess of this, namely, 360 r.p.m. The advantage in the cost and the efficiency of a motor for operating these two pumps is distinctly in favor of the screw pump.

Furthermore, the screw pump is a much lighter pump, requiring less expensive foundations, and it is easier to install. The 42-in. screw pump weighs 9,000 pounds, while the 36-in. centrifugal pump weighs 21,000 pounds. This shows that the body of the screw pump is much smaller than that of the centrifugal pump in spite of the fact that the pipe sizes are larger than the latter.

In addition to this, the arrangement for pumping over levees, or between canals at different levels, is much more simple for the screw pump than for the centrifugal pump. The property through which the canal runs is always long and narrow and the screw pump, together with its prime mover, makes a long narrow installation which lends itself to the shape of the property in which it is to be installed.

The centrifugal pump is usually a more costly pump to produce than the screw pump, and this is especially true of the pump with the characteristics shown in Fig. 2 because of the fact that this 36-in. pump has a Francis runner.

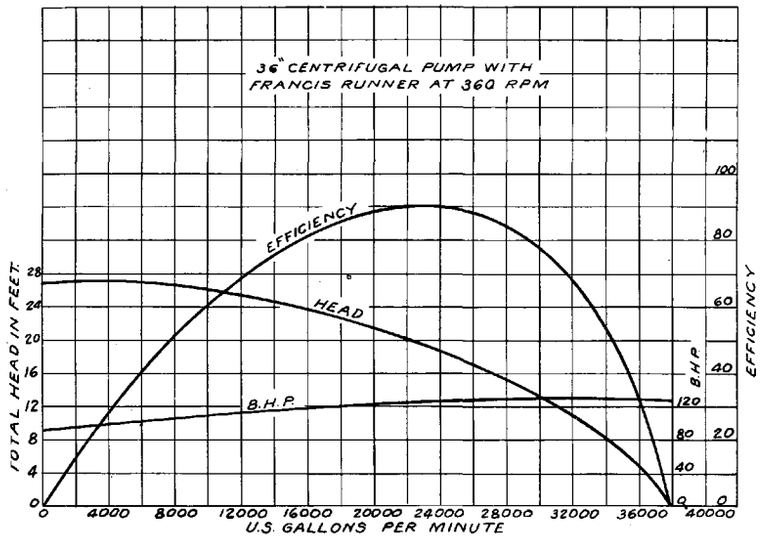


Fig. 2. Complete performance curve of a 36-in. centrifugal pump with Francis runner at 224 r.p.m.

The Francis runner is known for its efficiency at low heads and in this case the curve reaches the unusually high maximum point of 90 per cent. This is partly due to the special design and partly due to the very careful workmanship and careful testing of the unit in question. The screw pump, on the other hand, had a cast-steel runner whose surfaces were only partially smooth. No great effort was made to bring up its point of maximum efficiency, and therefore it does not exceed 76 per cent at any point. Yet, even in the face of these handicaps of workmanship and finish on the particular units which were selected for this comparison, the screw pump is shown to be inherently a more efficient pump at low heads. It does not take a great deal of imagination to see how the screw pump efficiency curve of Fig. 3 would compare with the centrifugal pump efficiency curve had its blades been made of bronze and highly polished so as to reach a maximum point somewhere above 80 per cent.

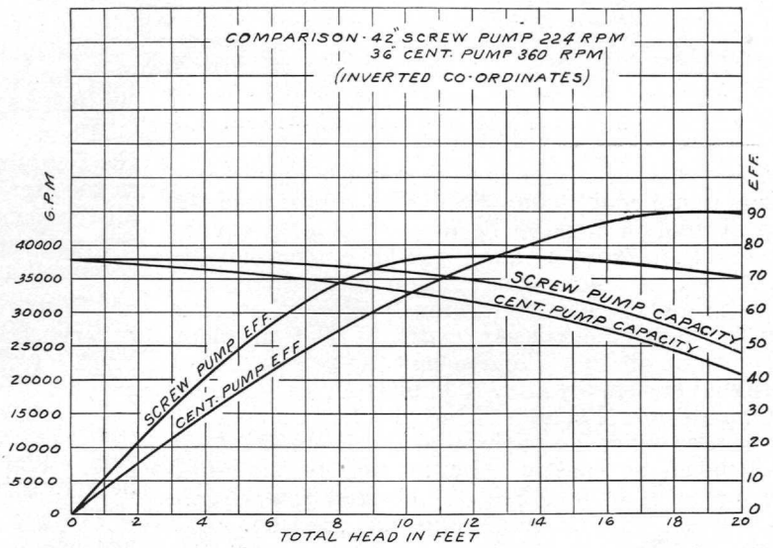


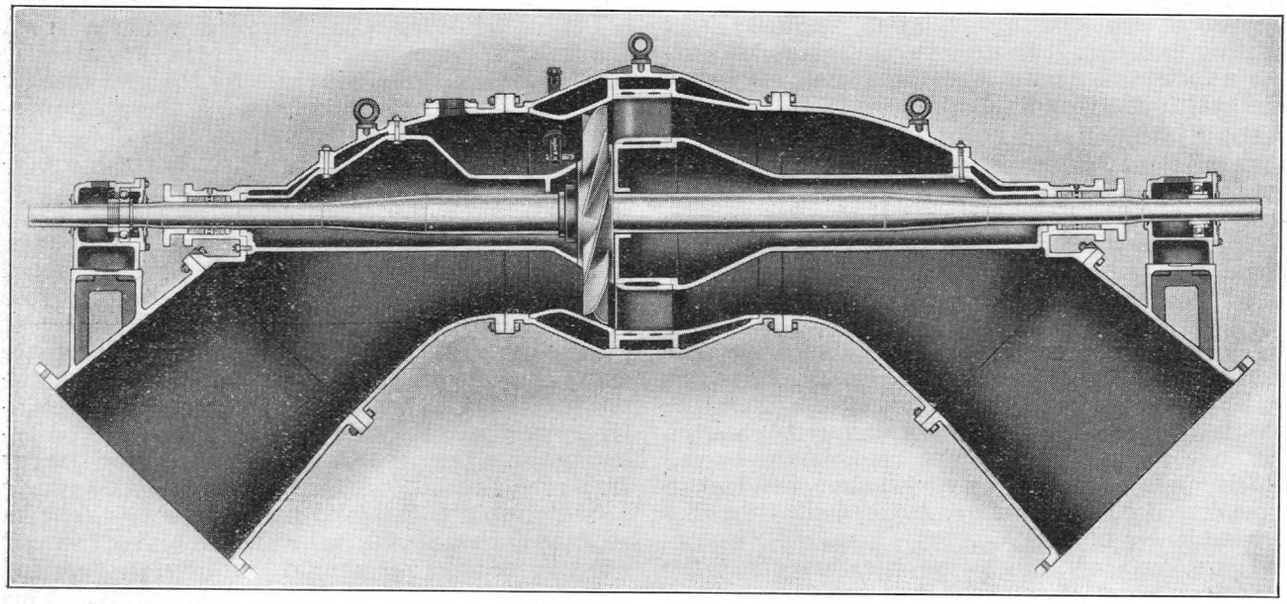
Fig. 3. Combined curve of screw pump and centrifugal pump drawn with inverted co-ordinance to show the variation of the pump efficiencies under low head conditions.

The curves shown in Fig. 3 are out of the ordinary in that they are plotted against the total head rather than against the conventional gallons per minute. This is done because the comparisons are at low heads rather than at a given capacity. By using this method of plotting, it can readily be observed that at low heads the efficiencies of the two pumps can be read directly from the chart. For example, at a head of 6 ft. the efficiency of the screw pump is 57 per cent while that of the centrifugal pump is only 42 per cent. This same information could be taken from the other curves but it would be inconvenient to do so. To get the efficiency from Fig. 1 it is necessary first to read the capacity. At 6 ft. the capacity is approximately 37,000 g.p.m. The efficiency is quite indefinite on account of the steepness of the curve; but it is apparent that it checks approximately with the reading given in Fig. 3; namely, 57 per cent. Also in Fig. 2 it is necessary first to read the capacity and then the efficiency, which checks with Fig. 3 and is 42 per cent. In addition to this, Fig. 1 and Fig. 2 would not make a graphical comparison even if plotted on the same sheet.

The important point which should be kept in mind is that these curves may not show up the screw pump to advantage when read in their entirety but that at the extreme right where the points of low working heads exist the advantages of the screw pump begin to assert themselves. It is under these conditions that a screw pump should be used.

In general, these curves have demonstrated, directly or indirectly, most of the advantages of the screw pump over the centrifugal as follows:

Higher efficiency at low heads, higher speed, lighter weight, smaller dimensions, lower first cost, lower cost of installation, cheaper motor, more efficient motor, low head installation.



Section through a reversible type screw pump. Pumps of this type have been built 12 ft. in diameter with a capacity of 360,000 gallons per minute each. They are also built in sizes about down to 24 in. Pumps of this type are used particularly in connection with large irrigation and drainage projects or in any work where large volumes are to be handled at low heads. All of the rainfall on the area covered by the City of New Orleans is pumped over the levees with equipment of this type.